Randomised controlled trial of telemonitoring with addition of daily forced oscillation in older people with COPD and co-morbidity (CHROMED)

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Conflict of Interest

- Dr Paul Walker has received payment to lecture at education meetings from Astra Zeneca, Chiesi and Novartis. His department has received funding to recruit to research studies from GlaxoSmithKline, Bayer and Pharmaxis (no personal funding)
- Prof Peter Calverley has advised pharmaceutical companies about the conduct of clinical trials in COPD, including GSK, Boehringer Ingelheim, Novartis, Takeda Nycomed, Chiesi and Almirall. He has spoken at meetings supported in whole or in part by these companies
- Dr Pasquale Pompilio and Prof Raffaele Dellaca own shares in Restech srl that produces the Resmon Pro Diary

Telemonitoring in People with COPD

- Most randomised controlled trials of remote monitoring in COPD have typically monitored symptoms via a remote electronic platform with basic physiological information (including FEV_1) collected in some cases
- Many studies are modest in size and outcomes generally negative
- The largest study by Pinnock H et al (BMJ 2013) monitored symptoms, treatment and O_2 saturations and found no impact on hospitalisation or health status
- It is currently not clear that telemonitoring provides added value to self-management though there may be benefit in sub-groups

CHROMED: Clinical trial of elderly patients with multiple disease

- The study aimed to test the health and economic effectiveness of adopting an innovative home-monitoring platform based on simple physiological measurement (forced oscillation) to manage elderly COPD with comorbidities
- EU-funded (FP7) multi-centre clinical trial involving 300 patients in 6 European clinical centers with 3 technical partners
- The study ran from October 2013 to March 2016

SEVENTH FRAMEWORK PROGRAMME

Chromed

Clinical and Technical Centres

Clinical Centres

- Aintree Hospital, University of Liverpool, UK (38 patients)
- University of Lincoln, UK (32 patients)
- University of Barcelona, Spain (60 patients)
- Uppsala University, Sweden (60 patients)
- Tallinn University of Technology, Estonia (78 patients)
- Bolnisnica Sežana Zavod, Slovenia (32 patients)

Technical Centres

- Elettronica Biomedicale (EBM), Italy: project manager
- RESTECH srl, Italy: technical manager
- University Hospital of North Norway (UNN): impact manager

Study Design

- 300 subjects were randomised 1:1 to either home monitoring (**monitored**) or not (**control**) for 9 months
- Home monitoring consisted of:
  - Daily measurement of lung mechanics and breathing pattern using Resmon Pro Diary
  - plus for heart failure patients: daily pulse, BP, O_2 sats and weight
- Daily symptom questionnaires recorded by all (not used to generate alerts) and multiple other questionnaires including EQ5D, EQ5D-VAS, CAT, PRQ, healthcare utilisation, satisfaction and MHLF (heart failure patients only)
- Primary outcomes: the study was powered with 90% chance to find 25% increase in time to first hospitalisation (TTFH) and 15% improvement in quality of life measured by EQ5D at 9 months

Resmon Pro Diary

- Set up in the home of the monitored subjects
- Daily 2 minute forced oscillation recording with cheeks compressed and wearing nose clips
- Measurement of airway resistance and reactance by forced oscillation

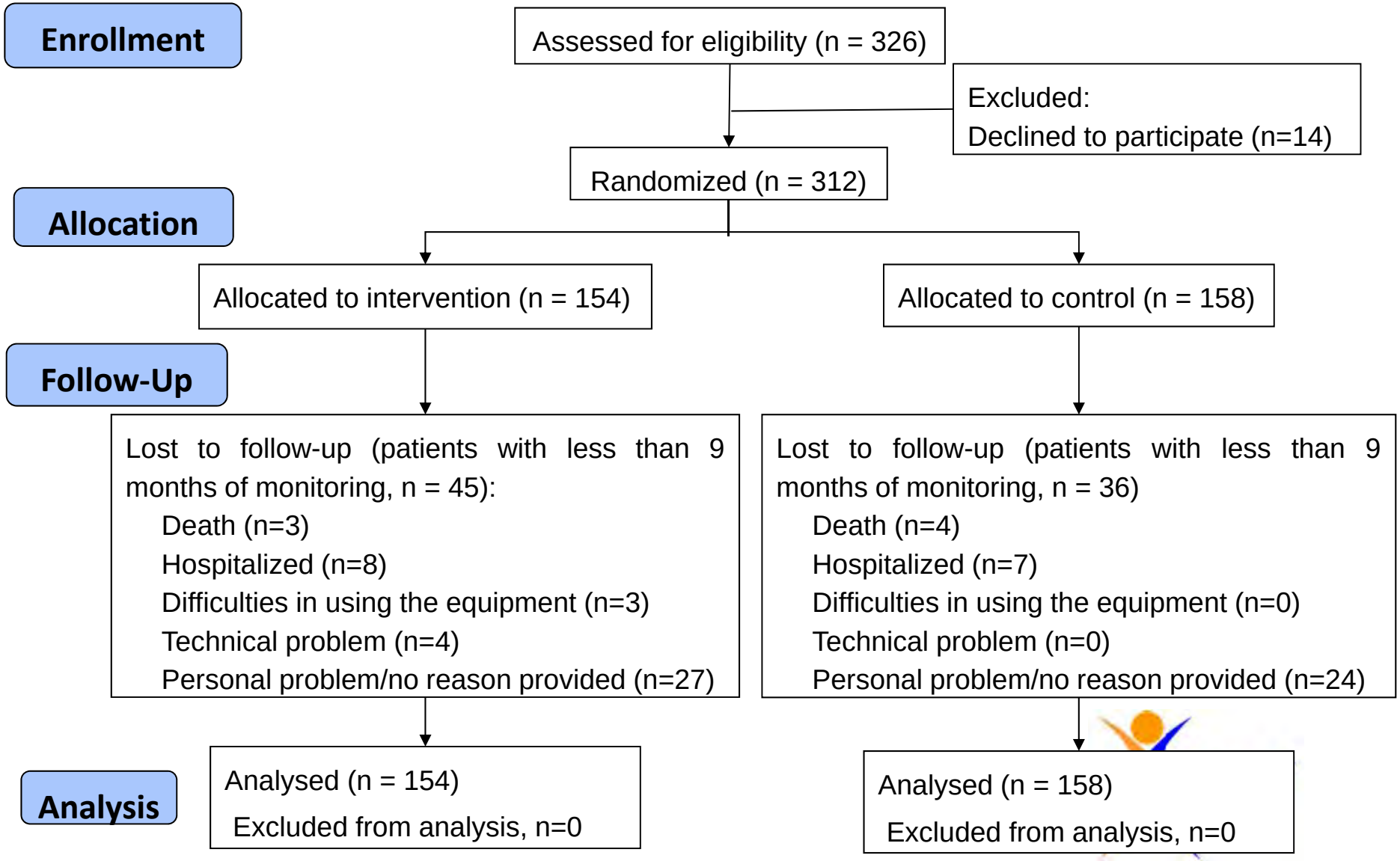
Management of Alerts

- The alert algorithm was based on a previous study in Italy recruiting people with severe COPD
- Subjects were recruited when clinically stable and underwent a period of monitoring (usually 1-2 weeks) to establish their baseline
- A **sustained** worsening in forced oscillation measurements led to an alert sent to the clinical centre
- It was the responsibility of the clinical centre to contact study subject and decide if action was required
- Alerts were also sent where data was missing with the option to 'pause'

Inclusion Criteria

- At least moderate COPD – FEV_1/FVC <0.7 and FEV_1 <80% predicted
- At least 10 pack years cigarette smoking
- Aged at least 60 years but sites requested to recruit 65 years or older where possible
- At least 1 COPD exacerbation and/or hospitalisation during the previous year
- At least 1 co-morbidity – CCF (LVSD on echo), IHD, hypertension, SDB (AHI >5), OHS, treated hyperlipidaemia, treated osteoporosis
- Mobile phone coverage at home and able to use equipment
- No plan for extended absence from home during the study

Diagram of Study flow



Baseline Characteristics

	Monitored (n=154)	Control (n=158)
Sex (male/female)	101/53	105/53
Age (years)	71	71
Pack years	40	40.5
FEV_1 (L/% predicted)	1.3 (49.4%)	1.3 (50.4%)
FEV_1/FVC	0.5	0.51
SGRQ	46.2	50.9
Exacerbation last year	1 = 41%, 2+ = 59%	1 = 37%, 2+ = 63%
Hospitalisation last year	42%	41%
GOLD II/III/IV (%)	47/36/15	48/39/11
Co-morbidity (%):		
CCF	12	8
IHD	25	23
CCF + IHD	12	13
Hypertension	72	68
OSA/OHS	11	6
Osteoporosis	17	15
Hyperlipidaemia	53	58

Data Completeness

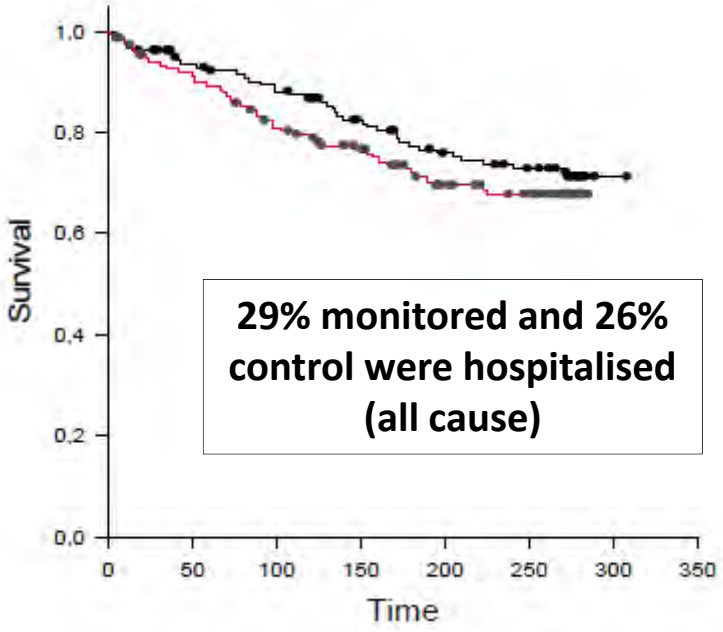
	Monitor	Control
Resmon Pro	89%	NA
COPD questionnaire	89%	85%
CCF questionnaire	97%	71%

Excludes:

- Days in hospital
- Days absent from home on holiday/vacation

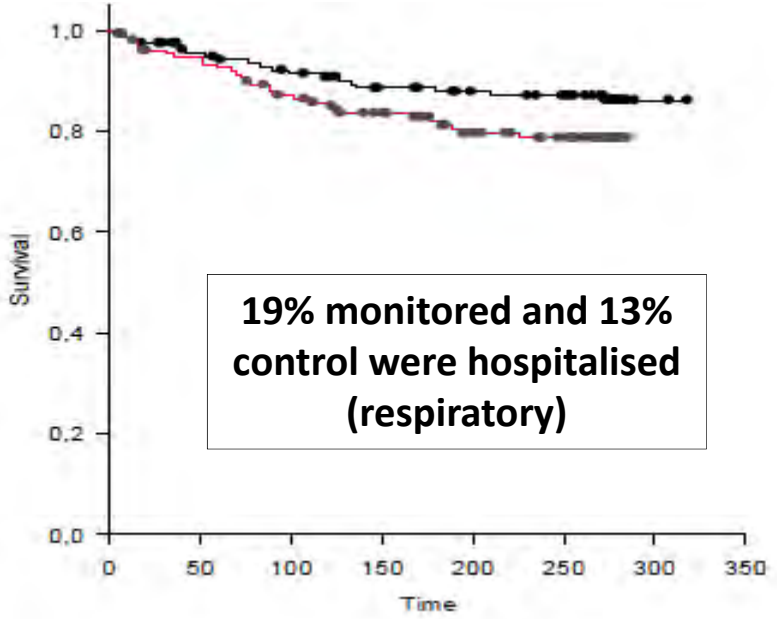
Overall Study Results – Time to First Hospitalisation

All cause



29% monitored and 26% control were hospitalised (all cause)

Respiratory



19% monitored and 13% control were hospitalised (respiratory)

Black = control Red/grey = monitored

Mean TTFH all cause:	Monitored: 224 days	Control: 225 days (ns)
Mean TTFH respiratory:	Monitored: 244 days	Control: 287 days (ns)

Hospitalisation Number and Bed Days

	Monitored (n=154)	Control (n=158)	p value
Hospitalisation overall	79	103	ns
Respiratory	45	59	ns
Cardiac	7	5	ns
Days in hospital	329	650	ns
Respiratory	256	543	ns
Cardiac	45	18	ns

EQ5D

	Monitor	Control	p value
Baseline	0.64	0.66	ns
3 months	0.66	0.63	ns
6 months	0.64	0.68	ns
9 months	0.64	0.64	ns

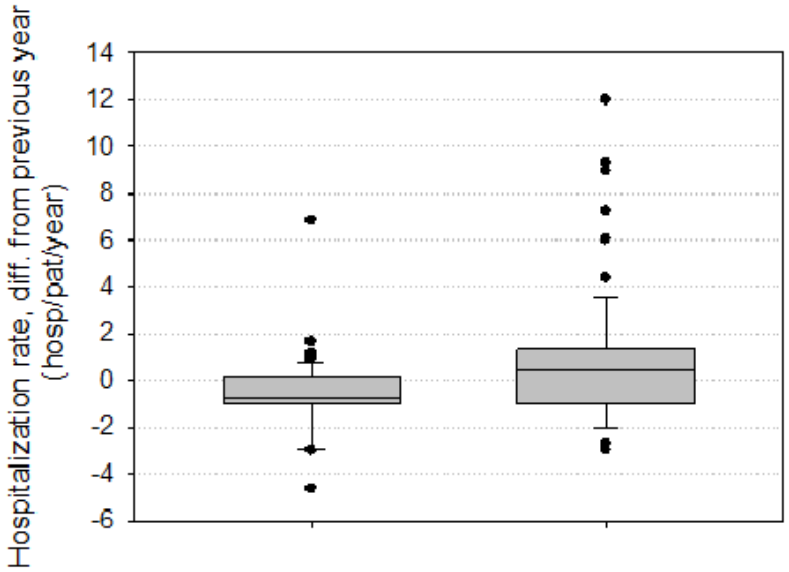
Cost Effectiveness

	Monitor*	Control*
Hospital	€2039	€3318
Community	€1398	€1513
Healthcare sub total	*€3437*	*€4831*
Medical alarms	€110	0
Technical alarms	€393	0
Equipment	€675	0
Technical sub total	*€1177*	*€0*
Total	**€4615**	**€4831**

* Based on UK figures

Subgroup: Individuals with 1 or more hospitalization in the previous year

Hospitalisation rate



Rate = -0.79 **Rate = +0.38**

p=0.04

Cost effectiveness

	Cost(€), mean (SD)	
	Control(n=63)	Monitored(n=61)
Hospitalizations	€ 4,700.00 (10312)	€ 1,968.00 (5034)
ED presentation	€ 84.00 (170)	€ 35.00 (84)
Early discharge	€ 37.00 (205)	€ 18.00 (138)
Hospital-at-home	€ 32.00 (146)	€ - 0
Outpatient visti	€ 277.00 (492)	€ 310.00 (570)
Ambulance	€ 128.00 (314)	€ 148.00 (511)
Primary care		
GP office	€ 690.00 (949)	€ 659.00 (852)
District nurse	€ 736.00 (1033)	€ 745.00 (944)
Specialist nurse	€ 96.00 (423)	€ 28.00 (144)
Physiotherapist	€ 123.00 (451)	€ 81.00 (243)
Other	€ 47.00 (171)	€ 45.00 (198)
TOTAL 9 months	**€ 6,950.00**	**€ 4,037.00**
TOTAL per year	**€ 9,266.67**	**€ 5,382.67**

Potential €3884 savings per patient per year

Conclusions

- Daily monitoring with forced oscillation did not change time to first hospitalisation, hospitalisation rate or health status
- In sub-group analysis people who were hospitalised in the previous year showed a lower hospitalisation rate with a potential significant cost saving and they may benefit from telemonitoring and earlier treatment

With thanks to…

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Additional slides

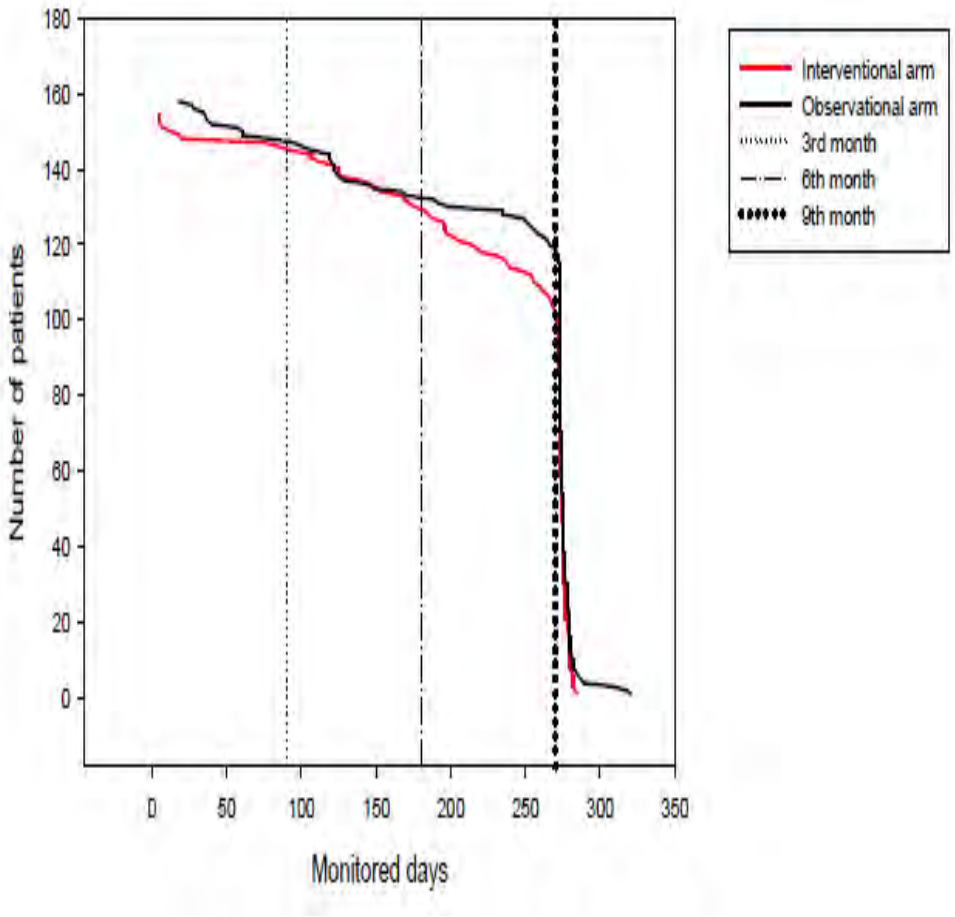
Alerts

- 793 respiratory alerts = median (IQR) 0.55 (0.27-0.87) alerts/patient/month
- 647 'clustered' (worsening) respiratory alerts = median (IQR) 0.53 (0.29-0.66) alerts/patient/month
- 50% of alerts associated with a change in at least one symptom
- 222/647 (34%) required intervention after telephone discussion

- <u>Symptoms</u>
- Breathlessness 22%
- Cough 14%
- Change in phlegm 14%
- Sore throat or 'cold' 14%
- Less energy 12%
- Worse sleep 6%
- Wheeze 5%

- <u>Treatment</u>
- Change in current treatment 29%
- Addition of treatment 18%
- Visit by doctor or nurse 34%
- Hospitalisation 3%
- Suggested treatment refused 9%

Drop Out



- By the end of the study drop out was:
- 45 (29%) in monitored arm
- 36 (23%) in control arm
- This did not differ significantly between groups